WHAT IS CLAIMED IS:

1. An opto-acoustic wave sensor for detecting a presence, determining a location, and quantifying an amount of at least a chemical species, said opto-acoustic wave sensor comprising:

(1) an opto-acoustic wave sensing element that comprises an acoustic wave element, two electrodes coupled to said acoustic wave element, and a coating being disposed on at least one portion of said acoustic wave element and comprising at least one reagent that is capable of undergoing a selective chemical interaction with said chemical species to be detected to yield at least one optically detectable interaction product;

(2) a source of electromagnetic ("EM") radiation optically coupled to said opto-acoustic wave sensing element, said EM radiation source providing EM radiation having a wavelength that is matched to an optical property of said product of said chemical interaction;

(3) a first detector for detecting a change in a property of said opto-acoustic wave sensing element, which property is selected from the group consisting of mass, viscoelastic, and dielectric properties; and

(4) a second detector for detecting said optical property of said interaction product.

2. The opto-acoustic wave sensor according to claim 1, wherein said acoustic wave element is selected from the group consisting of a TSM sensor, a SAW sensor, a FPW sensor, and a SH-APM sensor.

3. The opto-acoustic wave sensor according to claim 1, wherein said acoustic wave element is a TSM sensor.

4. The opto-acoustic wave sensor according to claim 3, wherein said TSM sensor is a QCM.

5. The opto-acoustic wave sensor according to claim 4, wherein said QCM comprises a quartz crystal element selected from the group consisting of an AT-cut quartz crystal element and a BT-cut quartz crystal element.

6. The opto-acoustic wave sensor according to claim 1, wherein said acoustic wave element is a SAW sensor.

7. The opto-acoustic wave sensor according to claim 4, wherein said coating is disposed on at least one electrode of said sensor.

8. The opto-acoustic wave sensor according to claim 6, wherein said coating is disposed on a surface of said sensor and between said electrodes.

9. The opto-acoustic wave sensor according to claim 1, wherein said coating comprises a porous permeable polymeric material.

10. The opto-acoustic wave sensor according to claim 9, wherein said polymeric material is selected from the group consisting of polytetrafluoroethylene ("PTFE"), poly(vinyl chloride) ("PVC"), poly(vinyl alcohol) ("PVA"), polyurethane, polyolefins such as polyethylene or polypropylene, polycarbonate, polystyrene, polyamide, poly(vinylidene fluoride) ("PVDF"), polyarylsuphones, polyacrylonitrile, polyether, polyetherurethane, poly(ether thioether), poly(methyl methacrylate), polyvinylpyrrolidone, polysiloxane, nylon, cellulose and its derivatives, copolymers thereof, and blends thereof.

11. The opto-acoustic wave sensor according to claim 10, wherein said coating has a thickness in a range from about 10 nm to about 100 micrometers.

12. The opto-acoustic wave sensor according to claim 11, wherein said thickness is preferably in a range from about 20 nm to about 50 micrometers, and more preferably from about 20 nm to about 10 micrometers.

13. The opto-acoustic wave sensor according to claim 9, wherein said porous permeable polymeric material has pore size in a range from about 1 nm to about 200 nm.

14. The opto-acoustic wave sensor according to claim 13, wherein said pore size is preferably in a range from about 1 nm to about 100 nm, and more preferably from about 1 nm to about 50 nm.

15. The opto-acoustic wave sensor according to claim 1, wherein said coating comprises a porous solid substrate supporting a polymeric material selected from the group consisting of polytetrafluoroethylene ("PTFE"), poly(vinyl chloride) ("PVC"), poly(vinyl alcohol) ("PVA"), polyurethane, polyolefins such as polyethylene or polypropylene, polycarbonate, polystyrene, polyamide, poly(vinylidene fluoride) ("PVDF"), polyarylsuphones, polyacrylonitrile, polyether, polyetherurethane, poly(ether thioether), poly(methyl methacrylate), polyvinylpyrrolidone, polysiloxane, nylon, cellulose and its derivatives, copolymers thereof, and blends thereof.

16. The opto-acoustic wave sensor according to claim 11, wherein said porous substrate comprises a material selected fro the group consisting of glass, quartz, and piezoelectric materials.

17. The opto-acoustic wave sensor according to claim 1, wherein said coating is porous and said reagent is chemically attached to a surface of said coating.

18. The opto-acoustic wave sensor according to claim 1, wherein said coating is porous, and a mixture of said reagent and a matrix material is deposited in said porous coating.

19. The opto-acoustic wave sensor according to claim 1, wherein said EM radiation has a wavelength is in a range from UV to IR.

20. The opto-acoustic wave sensor according to claim 19, wherein said wavelength is in a range from about 100 nm to about 1mm.

21. The opto-acoustic wave sensor according to claim 1, wherein said optical property of said product is selected from the group consisting of absorbance and intensity of an emission of EM radiation.

22. The opto-acoustic wave sensor according to claim 1, wherein said first detector measures a change in a resonant frequency of said acoustic wave element and relates said change to a change in a mass thereof.

23. The opto-acoustic wave sensor according to claim 1, wherein said first detector measures a change in at least one parameter of the acoustic wave-sensing element, said at least one parameter being selected from the group consisting of fundamental oscillation frequency, harmonic oscillation frequency, impedance phase and amplitude, impedance phase and attenuation, wave velocity, wave attenuation, capacitance, and conductance and relates said change to a change in a mass of said acoustic wave-sensing element.

24. The opto-acoustic wave sensor according to claim 1, wherein said second detector measures a optical signal selected from the group consisting of absorbance and intensity of an emission of EM radiation.

25. The opto-acoustic wave sensor according to claim 1, wherein said chemical species is selected from the group consisting of halogenated hydrocarbons, polynitroaromatic hydrocarbons, mono-substituted benzene, aromatic aldehydes, aromatic amines, and mixtures thereof.

26. The opto-acoustic wave sensor according to claim 1, wherein said halogenated hydrocarbons are trichloroethylene, thrichloroethane, chloroform, bromoform, chlorodibromomethane, and bromodichloromethane.

27. The opto-acoustic wave sensor according to claim 25, wherein said polynitroaromatic hydrocarbons are 1,3,5-trinitrobenzene; 2,4,6-trinitrobiphenyl; 2,3',4,5',6-pentanitrobiphenyl; 2,2',4,4',6,6'-hexanitrobiphenyl; 2,4,6-trinitrotoluene; 2,2',4,4',6,6'-hexatrinitrobiphenyl; 2,2',4,4',6,6'-hexanitrostilbene; 2,2'4,4'-tetranitrobiphenyl; 3,3',5,5'-tetranitrobiphenyl; 2,2',6,6'-tetranitrobiphenyl; 1,4,5,8-tetranitronaphthalene; 1,3-dinitrobenzene; 2-ethoxy-1,3,5-trinitrobenzene; 2-methyl-1,3-dinitrobenzne; 2,4-dimethyl-1,3-dinitrobenzne; and mixtures thereof.

28. The opto-acoustic wave sensor according to claim 25, wherein said mono-substituted benzene has a formula of Ar-X, wherein Ar is a phenyl radical and X is a radical selected from the group consisting of $-CH_3$, $-OCH_3$, $-C_6H_5$, $-SCH_3$, and $-SC_6H_5$.

29. The opto-acoustic wave sensor according to claim 25, wherein said aromatic aldehydes are benzaldehyde, 1-naphthaldehyde, 9-anthraldehyde, 4-dimethylaminocinnamaldehyde, 2-nitrobenzaldehyde, and 4-nitrobenzaldehyde.

30. The opto-acoustic wave sensor according to claim 25, wherein said aromatic amines are pyridine and alkyl-substituted pyridines.

31. The opto-acoustic wave sensor according to claim 1 further comprising at least one optical waveguide optically coupled to said opto-acoustic wave sensing element; said optical waveguide receiving EM radiation generated by said source of EM radiation and carrying EM radiation to and from said opto-acoustic wave sensing element.

32. The opto-acoustic wave sensor according to claim 31, wherein said optical waveguide comprises an optical fiber.

33. The opto-acoustic wave sensor according to claim 31, wherein said optical waveguide comprises a bundle of optical fibers.

34. The opto-acoustic wave sensor according to claim 32 further comprising a lens that is interposed between said optical fiber and said opto-acoustic wave sensing element.

35. The opto-acoustic wave sensor according to claim 1, wherein said at least one reagent is selected from the group consisting of organic, inorganic, biochemical molecules, and nucleic acid.

36. An opto-acoustic wave sensor for detecting a presence, determining a location, and quantifying an amount of at least a chemical species, said opto-acoustic wave sensor comprising:

(1) an opto-acoustic wave sensing element that comprises an acoustic wave element, two electrodes coupled to said acoustic wave element, and a coating being disposed on at least one portion of said acoustic wave element and comprising at least one reagent that is capable of undergoing a selective chemical interaction with said chemical species to be detected to yield at least one optically detectable interaction product;

(2) a source of electromagnetic ("EM") radiation optically coupled to said opto-acoustic wave sensing element, said EM radiation source providing EM radiation having a wavelength that is matched to an optical property of said product of said chemical interaction;

(3) a first detector for detecting a change in a property of said opto-acoustic wave sensing element, which property is selected from the group consisting of mass, viscoelastic, and dielectric properties; and

(4) a second detector for detecting said optical property of said interaction product;

wherein said coating comprises a porous solid substrate supporting a polymeric material selected from the group consisting of polytetrafluoroethylene ("PTFE"), poly(vinyl chloride) ("PVC"), poly(vinyl alcohol) ("PVA"), polyurethane, polyolefins such as polyethylene or polypropylene, polycarbonate, polystyrene, polyamide, poly(vinylidene fluoride) ("PVDF"), polyarylsuphones, polyacrylonitrile, polyether, polyetherurethane, poly(ether thioether), poly(methyl methacrylate), polyvinylpyrrolidone, polysiloxane, nylon, cellulose and its derivatives, copolymers thereof, and blends thereof; said acoustic wave element is selected from the group consisting of a TSM sensor, a SAW sensor, a FPW sensor, and a SH-APM sensor; said optical property is selected from the group consisting of absorbance and intensity of emission of EM radiation; and said wavelength is in a range from about 100 nm to about 1mm.

37. A method for detecting a presence, determining a location, and quantifying an amount of at least a chemical species, said method comprising:

(1) providing:

(a) an opto-acoustic wave sensing element that comprises an acoustic wave element, two electrodes coupled to said acoustic wave element, and a coating; said coating being disposed on at least a portion of said acoustic wave element and comprising at least one reagent that is capable of undergoing a selective chemical interaction with said chemical species to yield at least one optically detectable interaction product;

(b) a source of EM radiation optically coupled to said opto-acoustic wave element, said EM radiation having a wavelength that is matched to an optical property of said product of said selective chemical interaction;

(c) a first detector for detecting a change in a property of said opto-acoustic wave sensing element, which property is selected from the group consisting of mass, viscoelastic, and dielectric properties; and

(d) a second detector for detecting said optical property of said interaction product;

(2) allowing said chemical species to selectively interact with said at least one reagent to yield said at least one optically detectable product and to change said mass of said opto-acoustic wave element

(3) launching into said opto-acoustic wave sensing element at least an input beam of EM radiation at said selected wavelength, said input beam having a radiation optical property

(4) collecting an output beam of said EM radiation having a changed radiation optical property;

(5) relating said change in said radiation optical property to an identity and an amount of said chemical species; and

(6) relating said change in said property of said opto-acoustic wave sensing element to said identity and said amount of said chemical species at a location of said opto-acoustic wave sensing element.

38. The method according to claim 37, wherein said acoustic wave element is selected from the group consisting of a TSM sensor, a SAW sensor, a FPW sensor, and a SH-APM sensor.

39. The method according to claim 37, wherein said acoustic wave element is a TSM sensor.

40. The method according to claim 39, wherein said coating is disposed on at least one electrode of said sensor.

41. The method according to claim 39, wherein said TSM sensor is a QCM.

42. The method according to claim 41, wherein said QCM comprises a quartz crystal element selected from the group consisting of an AT-cut quartz crystal element and a BT-cut quartz crystal element.

43. The method according to claim 37, wherein said acoustic wave element is a SAW sensor.

44. The method according to claim 42, wherein said coating is disposed on a surface of said sensor and between said electrodes.

45. The method according to claim 37, wherein said coating comprises a porous permeable polymeric material.

46. The method according to claim 45, wherein said polymeric material is selected from the group consisting of polytetrafluoroethylene ("PTFE"), poly(vinyl chloride) ("PVC"), poly(vinyl alcohol) ("PVA"), polyurethane, polyolefins such as polyethylene or polypropylene, polycarbonate, polystyrene, polyamide, poly(vinylidene fluoride) ("PVDF"), polyarylsuphones, polyacrylonitrile, polyether, polyetherurethane, poly(ether thioether), poly(methyl methacrylate), polyvinylpyrrolidone, polysiloxane, nylon, cellulose and its derivatives, copolymers thereof, and blends thereof.

47. The method according to claim 46, wherein said coating has a thickness in a range from about 10 nm to about 100 micrometers.

48. The method according to claim 47, wherein said thickness is preferably in a range from about 20 nm to about 50 micrometers, and more preferably from about 20 nm to about 10 micrometers.

49. The method according to claim 45, wherein said porous permeable polymeric material has pore size in a range from about 1 nm to about 200 nm.

50. The method according to claim 49, wherein said pore size is preferably in a range from about 1 nm to about 100 nm, and more preferably from about 1 nm to about 50 nm.

51. The method according to claim 37, wherein said coating comprises a porous solid substrate supporting a polymeric material selected from the group consisting of polytetrafluoroethylene ("PTFE"), poly(vinyl chloride) ("PVC"), poly(vinyl alcohol) ("PVA"), polyurethane, polyolefins such as polyethylene or polypropylene, polycarbonate, polystyrene, polyamide, poly(vinylidene fluoride) ("PVDF"), polyarylsuphones, polyacrylonitrile, polyether, polyetherurethane, poly(ether thioether), poly(methyl methacrylate), polyvinylpyrrolidone, polysiloxane, nylon, cellulose and its derivatives, copolymers thereof, and blends thereof.

52. The method according to claim 51, wherein said porous substrate comprises glass.

53. The method according to claim 37, wherein said coating is porous and said reagent is chemically attached to a surface of said coating.

54. The method according to claim 37, wherein said coating is porous, and a mixture of said reagent and a matrix material is deposited in said porous coating.

55. The method according to claim 37, wherein said EM radiation has a wavelength is in a range from UV to IR.

56. The method according to claim 55, wherein said wavelength is in a range from about 100 nm to about 1mm.

57. The method according to claim 37, wherein said optical property of said product is selected from the group consisting of absorbance and intensity of an emission of EM radiation.

58. The method according to claim 37, wherein said first detector measures a change in a resonance frequency of said acoustic wave element and relates said change to a change in a mass thereof.

59. The method according to claim 37, wherein said second detector measures an optical signal selected from the group consisting of absorbance and intensity of an emission of EM radiation.

60. The method according to claim 37, wherein said chemical species is selected from the group consisting of halogenated hydrocarbons, polynitroaromatic hydrocarbons, mono-substituted benzene, aromatic aldehydes, aromatic amines, and mixtures thereof.

61. The method according to claim 60, wherein said halogenated hydrocarbons are trichloroethylene, thrichloroethane, chloroform, bromoform, chlorodibromomethane, and bromodichloromethane.

62. The method according to claim 60, wherein said polynitroaromatic hydrocarbons are 1,3,5-trinitrobenzene; 2,4,6-trinitrobiphenyl; 2,3',4,5',6-pentanitrobiphenyl; 2,2',4,4',6,6'-hexanitrobiphenyl; 2,4,6-trinitrotoluene; 2,2',4,4',6,6'-hexatrinitrobiphenyl; 2,2',4,4',6,6'-hexanitrostilbene; 2,2'4,4'-tetranitrobiphenyl; 3,3',5,5'-tetranitrobiphenyl; 2,2',6,6'-tetranitrobiphenyl; 1,4,5,8-tetranitronaphthalene; 1,3-dinitrobenzene; 2-ethoxy-1,3,5-trinitrobenzene; 2-methyl-1,3-dinitrobenzne; 2,4-dimethyl-1,3-dinitrobenzne; and mixtures thereof.

63. The method according to claim 60, wherein said mono-substituted benzene has a formula of Ar-X, wherein Ar is a phenyl radical and X is a radical selected from the group consisting of $-CH_3$, $-OCH_3$, $-C_6H_5$, $-SCH_3$, and $-SC_6H_5$.

64. The method according to claim 60, wherein said aromatic aldehydes are benzaldehyde, 1-naphthaldehyde, 9-anthraldehyde, 4-dimethylaminocinnamaldehyde, 2-nitrobenzaldehyde, and 4-nitrobenzaldehyde.

65. The method according to claim 60, wherein said aromatic amines are pyridine and alkyl-substituted pyridines.

66. The method according to claim 37, wherein said step of providing further comprises providing at least one optical waveguide optically coupled to said opto-acoustic wave sensing element; said optical waveguide receiving EM radiation generated by said source of EM radiation and carrying EM radiation to and from said opto-acoustic wave sensing element.

67. The method according to claim 66, wherein said optical waveguide comprises an optical fiber.

68. The method according to claim 66, wherein said optical waveguide comprises a bundle of optical fibers.

69. The method according to claim 67, wherein said step of providing further comprises providing a lens that is interposed between said optical fiber and said opto-acoustic wave sensing element.

70. The method according to claim 1, wherein said at least one reagent is selected from the group consisting of organic, inorganic, biochemical molecules, and nucleic acid.

71. A method for detecting a presence, determining a location, and quantifying an amount of at least a chemical species, said method comprising:

(1) providing:

(a) an opto-acoustic wave sensing element that comprises an acoustic wave element, two electrodes coupled to said acoustic wave element, and a coating; said coating being disposed on at least a portion of said acoustic wave element and comprising at least one reagent that is capable of undergoing a

selective chemical interaction with said chemical species to yield at least one optically detectable interaction product;

(b) a source of EM radiation optically coupled to said opto-acoustic wave element, said EM radiation having a wavelength that is matched to an optical property of said product of said selective chemical interaction;

(c) a first detector for detecting a change in a property of said opto-acoustic wave sensing element, which property is selected from the group consisting of mass, viscoelastic, and dielectric properties; and

(d) a second detector for detecting said optical property of said interaction product;

(2) allowing said chemical species to selectively interact with said at least one reagent to yield said at least one optically detectable product and to change said property of said opto-acoustic wave element

(3) launching into said opto-acoustic wave sensing element at least an input beam of EM radiation at said selected wavelength, said input beam having a radiation optical property;

(4) collecting an output beam of said EM radiation having a changed radiation optical property;

(5) relating said change in said radiation optical property to an identity and an amount of said chemical species; and

(6) relating said change in said property of said opto-acoustic wave sensing element to said identity and said amount of said chemical species at a location of said opto-acoustic wave sensing element;

wherein said coating comprises a porous solid substrate supporting a polymeric material selected from the group consisting of polytetrafluoroethylene ("PTFE"), poly(vinyl chloride) ("PVC"), poly(vinyl alcohol) ("PVA"), polyurethane, polyolefins such as polyethylene or polypropylene, polycarbonate, polystyrene, polyamide, poly(vinylidene fluoride) ("PVDF"), polyarylsuphones, polyacrylonitrile, polyether, polyetherurethane, poly(ether thioether), poly(methyl methacrylate), polyvinylpyrrolidone, polysiloxane, nylon, cellulose and its derivatives, copolymers thereof, and blends thereof; said acoustic wave element is selected from the group consisting of a TSM sensor, a SAW sensor, a FPW sensor, and a SH-APM sensor; said optical property is selected from the group consisting of absorbance and intensity of emission of EM radiation; and said wavelength is in a range from about 100 nm to about 1mm.

72. The method according to claim 37, wherein said method is used to detect a presence and to quantify products of a chemical synthesis that is conducted in a combinatorial chemistry experiment.

73. The method according to claim 37, wherein said method is used to detect a presence and to quantify products of a chemical analysis that is conducted in a combinatorial chemistry experiment.